ith the Author's compliments

KILLING OFF THE UNFIT

AND

THE TRANSMISSIBILITY OF ACQUIRED CHARACTERS.

3.

BY

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PART I.

KILLING OFF THE UNFIT.

By P. Z. Hebert, M.D.

We hear nowadays of most extraordinary theories. In America, recently, a well-meaning doctor is said to have advised the medical profession to kill off their tuberculous patients with morphine as quickly as possible, so as to remove all possible sources of infection; another advised mothers to have their children quietly put to sleep for ever when they are very young, and show signs of deformity or degeneracy. The same may soon be said of cancer patients and of the insane.

On our side of the Atlantic another enthusiast has recommended what he calls sterilization of the community by helping off the unfit on a large scale. Self-destruction has been lauded for various reasons, and many self-styled reformers would get rid of the drunkards by some rash method or other. Most of these theories are based on fallacies or on some misconception of the principles of evolution. It has long been held that tuberculosis was hereditary, and cancer, syphilis, insanity, drunkenness are, by the great majority—among them many scientists—considered hereditary; but no one considers cholera or influenza hereditary, yet the same principle is involved in these two cases as in tuberculosis. Tuberculosis is found to be produced by a micro-organism, the tubercle bacillus, and tuberculosis cannot be produced without it; the same applies to cholera and influenza, which are produced by their respective microbes. But we are told that in tuberculosis there is a tendency or a peculiar diathesis or constitutional character, which renders the subject more liable to the disease, and that this tendency is inherited. The same, however, can be said of subjects attacked by cholera or influenza, for, of a number of individuals who might be similarly exposed to an epidemic of these latter maladies, they would not all be infected, and those who would take these diseases should be considered as having inherited a tendency to such diseases, just the same as those who become the victims of tuberculosis.

But this qualification of hereditariness applied to certain diseases, and not to others, is greatly misleading, inasmuch as those characters which are looked upon as constituting the tendency are considered *per se* injurious; whereas those characters, under other circumstances, may be truly advantageous to the individual. It is like the case of the long thin legs of the antelope which are most fragile and easily fractured by accident, whereas, when pursued, such legs are most serviceable to the antelope for escaping from its enemies. It is all a question of relativity, and any peculiarity of a species or of an individual is generally of that nature, that it is favourable to them in a certain environment, but detrimental to them in another environment. To "kill off" tuberculous patients, then, to say nothing of the moral aspect of the question, would be like destroying antelopes because their legs got broken easily, without regard to the adaptation of their legs for another most useful purpose. That the members of one family should die of insanity, and those of another of foot disease, as from gout or otherwise, or those of a third of tuberculosis of the lungs, is no reason whatever why either should be "killed off." It would be as logical to "kill off" the former because the rest of their body lasts too long for their brain, or those affected with foot disease because their brain lasts too long for their feet. I say, beware of those theorists who want to "kill off" those who are not made to their liking. They are the unbalanced ones, they are the mental descendants of the inquisitors of old, their brains are too active for their bodies, and the other class of people could, with as much propriety, advocate killing them off for their peculiar views.

A Danish alienist, Dr. F. Lange, has recently published, in a book entitled "Degeneration in Families," his observations on 44 families, which have supplied, in less than 20 years, no less than 77 patients to the one asylum of which he is the Medical Superintendent. In addition to these he has traced in those families 358 distinctly abnormal cases of a neuropathic nature in the course of a few generations. These observations would probably confirm many of our present-day one-sided theorists in their sterilizing views, but those researches were carried further, and it was found that among the same families were discovered a very unusual proportion of highly distinguished persons. They include two cabinet ministers, an ambassador, three bishops, eight other prominent clergymen, three generals, three admirals, nine university professors, a large number of highly placed officials, twenty poets distributed over a space of a century, and some of them of the highest rank, twenty-four artists (painters, sculptors, musicians, etc.), about half of whom are known all over the country. In twenty-eight of these families, seventy-two individuals have reached prominent positions through special personal intellectual ability. This would suffice to give us an idea of the result of the appearance on the scene of some sterilizing genius at the inception of mental disease in these families, who would have taken to advocate successfully the sterilizing of families tainted with insanity, as well as the killing off of antelopes because their legs were so thin and long and got so easily broken.

Perhaps some well-meaning reformer might think that such a process would eliminate the insane altogether, and leave only the intellectual ones, but as well might one attempt to remove the shadows from a beautiful picture so as to leave only the high lights.

Now there is a point in heredity which has never, to my knowledge, been published respecting the tuberculous, which is that they are the improvers of the race in that direction. There are two methods open to us for saving humanity from the scourge of tuberculosis: (1) to destroy the tubercle bacillus, which, to my idea, appears to be a most difficult undertaking, if we are to attempt the entire destruction of the bacillus, so that not a vestige of it shall remain for its reproduction, even if killing off the tuberculous be resorted to; (2) the immunization of the race against the attacks of the bacillus, and this is what all those affected with tuberculosis are now doing for the human race. They are immunizing themselves gradually by their powers of reaction and adaptation, which increase with every generation, and the marrying of those who have been cured of the disease should be encouraged to the utmost by the State, in order to mingle their blood with others of the race, so as to preserve in their descendants the immunization gained by their cure for the benefit of the race. Even those who die of the disease have awaken in their tissues a certain amount of reaction which might be of some immunizing use in an offspring generated after such reaction, and might go to form a quota in the eventual immunization of the race.

So it will be seen that, far from being an advantage to "kill off" the tuberculous, it would be a distinct loss to the improvement of the race, and so long as the medical profession fails to find an efficient cure, of practical application, for that fell disease, they should allow the slow and sure immunization of the race by the tuberculous themselves, and when that cure is discovered, they can cure them instead of killing them off.

Something similar may be said of the drunkards, who are a valuable asset to the race or community, although this must not be taken in the sense that I consider them excusable for the hardships they inflict on others dependent upon them; but as a community asset, apart from paying the taxes imposed on drink, they are the means of immunizing the community against drunkenness by transmitting to their children a certain degree of immunization which, in the course of generations, will go to form a sober nation.

These statements will, I know, appear most paradoxical to the great majority of my readers. The propagation of tuberculous people and of drunkards is, so far as I know, discountenanced by nearly everybody who has written on the subject. The tuberculous taint is transmitted from generation to generation, they say, and the drunkards have children who are given no opportunity to be educated, who become drunkards themselves, and are a burden to the State.

This contention is a gross fallacy. The peculiar diathesis which constitutes a greater susceptibility to tuberculosis than the average in certain individuals—for we all have a certain susceptibility to it in a greater or less degree—is, no doubt, inherited, but the individual power of reaction and adaptation working for immunization, imparts characters which are transmitted in a certain degree to the offspring (we will return later on to that question of acquired characters), and which accumulates in the course of generations, so long as the race is exposed to the scourge, and gradually diminishes the natural susceptibility in proportion to the accumulation of immunization. The error which is generally made in the observation of this process of immunization is that it is so slow and gradual as to be generally overlooked and obscured by other circumstances not related to it, and by the mixture of other diatheses at every generation. For instance, in the case of the drunkard, it is often found that his home is neglected, his children are in rags and left to themselves, receiving little education, and this is taken to be inherited from the drunkard father; whereas these results are due to the privation and bad environment in which these children are placed, which may be the immediate result of the drunkenness of their parent, but is not inherited from him. By this I mean that any other children not of drunkard parents, who were placed in poverty and neglect, would show the same condition.

Now, it is necessary to say a word on the question of acquired characters, which some scientists, and, in particular, Weismann, have contended are not transmitted, the principal reason being, through stress of theory, that such transmission cannot be harmonised with Weismann's theory of germ-plasm, which, he says, contains all the potentialities of development and variation. It means that the environment has no effect in modifying character, and, therefore, that there is no power of adaptation to external conditions other than that those individuals, whose germ-plasm possesses the power of withstanding any adverse external influence, survive and transmit to their offspring those characters which enable them to survive, whilst the others die off. The other theory is that there is a reactive power in organisms, causing them to adapt themselves to external conditions, and to develop characters through the stimulus of environment, which can be, and are, transmitted to their descendants. According to the first theory, if a community were divided into two equal groups of individuals, and the first group engaged in manual labour for many generations, and the second group in mental labour for the same time, the first group would not acquire more physical development and power than the second, nor the second more mental development and power than the first, because none of the development and power acquired by the individuals of these groups, due to external stimulus, could be transmitted to their offspring, and they would only develop in the direction given by the nature of their germ-plasm. The second theory is that both groups would develop in the direction given by their environment, by transmitting the characters acquired through its stimulus and the adaptive reaction of the organism.

It may be that these two theories blend at one common point, that is, that the transmission of characters depends directly upon the nature of the germ-plasm, but that the nature of the germ-plasm depends upon the influence of the reaction of the organism caused by the stimulus offered by the environment. In this way, the direction of development would be given ultimately by the environment and adaptive power of the organism in accordance with the second theory; but Weismannists will see no causal relation between the reaction of the organism upon the stimulus of the environment and the required modification of the germ-plasm.

On the question of facts, for instance, Weismannists will argue that a man who has been all his life in India or South Africa has children just as white as he was himself when he was born; nay, that after several generations in the tropics, the children of white parents are just as white when born as children born in England. That may be so, and many errors are made in the science of evolution through looking for facts where there ought not to be any. In the first place, our experience in this respect is limited to a very few generations of Englishmen emigrating to India, and the example is irrelevant, because, although the characters developed and acquired at that period of the phylogenetic history of man, which is represented ontogenetically by the birth of the child, might reasonably be expected to be found at birth or in infancy, those developed at a period so late as our own time should not be so expected, any more than you should require to see children born with a beard to be convinced that this is inherited; indeed, were the white race, from some cause or other, to turn black from our own time on, it does not follow that their children should not continue to be born white as they are now, and only turn black at their ontogenetic age, which would correspond to our phylogenetic period of man's evolution; in fact, that is what we should expect from our present knowledge of evolution.

As evidence, however, of the transmission of acquired characters, and also as supporting my paradoxical statements that tuberculosis and drunkenness diminish with every generation, I will refer to the following historical facts. It is well known that the nations of southern Europe are much more sober than the English and the Scotch, and what is the reason of it? It is that from time immemorial the southern Europeans have cultivated the vine, and have consumed wine and alcohol for a great many generations. They have consequently become much more immunized than the English or the Scotch who have been consuming alcohol as a beverage for a much shorter time than the southern Europeans, because their land did not produce the vine naturally. A further evidence is found in the fact that all savage nations who have not had alcohol to consume as a common beverage are all given to drinking habits as soon as alcohol is introduced to them, and it must be noted here, both in corroboration of my paradoxical statements that it is the immunization which is transmitted, while the diathesis diminishes, and also of my contention of the transmission of acquired characters, that given a savage nation who has not tasted alcohol before, and to whom alcohol is introduced for regular consumption, it will, from that time, work its immunization and become more and more sober as the generations pass on, showing that the new environment was the incipience of its immunization, thus necessitating the assumption of the transmission of acquired characters which are not in the germ plasm, except as a power of adaptation to the environment.

Again, we know that small-pox and syphilis affect the white and dark races very differently, the mortality being immensely greater in the latter races than in the former, and, conversely, malarial fevers decimate the white population, whereas the dark races are comparatively very slightly affected by them. This is owing to the fact that small-pox and syphilis have been diseases of the white races for a very long period of time, and that they have acquired a comparative immunity from them, whilst the converse is the case with respect to malarial fevers, to which the dark races have been exposed for a great many generations, and have become comparatively immune to their effect on them. The difference of mortality between the two races in the case of small-pox and syphilis is an indication of the acquired immunity from those diseases by the white races, accumulated by transmission from generation to generation to our day, and, similarly, the smaller mortality of the dark races from malarial fevers is an indication, in them, of the degree of immunization acquired by them. I will admit, however, that relative mortality is a considerable factor in diminishing the number of the most susceptible, but it cannot be invoked as a cause of the increase of the actual degree of immunization in the most sober of an immunized community, as, also, in the most susceptible to disease.

But Weismannists would tell us, in reply, that we cannot give them any example of transmission of acquired characters, that the examples I am now adducing prove nothing, because they are accounted for by the assumed fact that the most susceptible to the disease have died off, and those who were immune, by the nature of their germ-plasm, have survived in their descendants. This reply implies that Weismannists know, or pretend to know, that the present immunized races have all descended from those individual ancestors of the human race who were least susceptible to the disease, and that none of those who were more susceptible have survived in their descendants, which is a pure assumption that they have no evidence to support, and without which their argument falls to the ground. The same thing applies to drunkenness as to disease. But there is evidence that among the nations immunized from drunkenness, the most sober individuals of them are more sober than the most sober of savage nations of the present day, which are a good example of what the ancestors of those now sober nations were before alcohol was introduced to them, and that an actual increase of sobriety or immunization from drunkenness must have taken place during a time when the nation was submitted to the influence of the introduction of alcoholic beverages, and that those characters acquired by individual members of those nations must have been transmitted, just as those individuals susceptible to a certain disease become less susceptible by adaptation; otherwise, whence could come that increase of sobriety which did not exist in the most sober of the savage ancestors?

PART II.

THE TRANSMISSIBILITY OF ACQUIRED CHARACTERS.

This question is still a moot one, notwithstanding that many scientists have made up their minds that these are not transmissible; but their arguments against the theory of transmission are so flimsy, and, in many cases, fallacious, that their conclusions cannot be accepted.

Fallacies.

In the first part of this paper I referred to the fallacious argument employed by Weismannists that the children of European descendants born in India are just as white at birth, even if their ancestors have lived in India for many generations, as the children born in England, and, therefore, show no sign of having acquired the Indian colour by transmission.

(2) Another argument urged against the theory of transmission of acquired characters is that the Jews have been submitted, as a race, to the rite of circumcision from time immemorial, and that their children are still born with a prepuce just the same as those of races which have never practised circumcision. The fact is that, according to the laws of ontogeny, if such mutilation was transmitted, the prepuce would continue to be formed until birth, as is the case in races not submitted to circumcision, and it is only from the time of birth that the prepuce should commence to atrophy, and, therefore, the only method of testing the effect of circumcision on the question of the transmission of acquired characters would be to discontinue circumcising children of the

Jewish race so as to observe the effect on adult uncircumcised Jews of the practice of circumcision upon their ancestors, and I believe that Darwin has recorded such an observation in the Mahommedans of Celebes, in whom the prepuce is very small.

(3) So confirmed in this method of argument are Weismannists that Prof. J. Arthur Thomson, M.A., of the Aberdeen University, in his article on "Heredity," in the *Encyclopædia Medica*, says:—"Of the direct evidence suggestive of the transmissibility of acquired characters, a few representative samples may be given: (1) The Panjabis are said to show peculiarities of musculature and skeleton which are related to the frequency with which these people assume the squatting posture, but it may be that these modifications are acquired during each individual lifetime. The evidence is inconclusive, and we may set against it the case of the compressed foot of Chinese ladies, for there seems to be no evidence that the long-continued deformation has resulted in any hereditary change in the Chinese *baby's foot*" (italics mine). Once more, the compression of the feet of Chinese ladies could not, according to the laws of ontogeny, alter the size of the Chinese baby's foot, and, therefore, this fact should not be looked upon as evidence against the transmission of acquired characters, as the influence of that compression could only commence to be felt after, and possibly considerably after, babyhood, and the only method of testing this example would be to discontinue the compression of the feet of Chinese ladies, and to compare the size of their feet in their adult or old age with that of other nations not submitted to such a custom, and not expect to find any change at all in the Chinese baby's foot.

But it speaks well for the accuracy of observation of Weismannists not to have found a smaller foot in the Chinese baby, nor a darker skin in the Indian-born European baby, as many enthusiasts often find facts where there are none.

Nor should we expect to find peculiarities of musculature and skeleton in the babies of Panjabis, if these are only being acquired during their life of exertion; but if the Panjabis can acquire, during their individual lifetime, peculiarities of which they can transmit the potentialities to their offspring which other races cannot transmit to theirs, because they have not acquired them, it follows that they are transmitting to their descendants acquired peculiarities which can lay the foundation of special characters in their race to differentiate them from the rest of mankind.

(4) Dr. Saleeby gives us another astonishing argument in an article, "Man *v.* Woman," published in the *Daily Chronicle* of the 20th of August, 1907. In this, he says:—". . . but whilst I omit much of moment, at least I may refer to the established truth that acquired characters are not inherited. That is to say, that my little girl, for instance, is no worse off as regards her mental prospects, because for thousands of generations most of her female ancestors have been educated little or not at all. In one generation a sex or a race may liberate itself from any such past."

This, to me, is assuming a mountain of fallacy, and shows how little the question appears to be understood by eminent men who consider the point as definitely settled. In the first place, Dr. Saleeby's little girl has just as many male as female ancestors to inherit from, and his boys, if he had any, would have as many female as male ancestors to inherit from. Why he should assume that either should inherit from one side only surpasses me, and his argument seems to me more in favour of the transmissibility of acquired characters than against it; however, I can assure Dr. Saleeby that he may rest in peace concerning the fate of his little girl on that score, whether acquired characters are inherited or not. Education is not merely learning the three R's, with a sprinkling of geography, and even of physics and of biology, etc. It is also the training one cannot fail to receive when living in an atmosphere of knowledge. Women cannot remain exclusively ignorant when brought up and trained in the company of educated men. The fact is that women produce a remarkable share of that education themselves; but Dr. Saleeby carries his argument to an extreme degree when he refers to "the thousands of generations of the female ancestors of his little girl as having been educated little or not at all," inviting us to assume as an antithesis that men had been thoroughly educated during those countless ages. It is, of course, perfectly evident that daughters inherit the same potentialities with regard to their mental endowments as sons, with a slight modification imparted by the circumstances of their sex.

Confusing Terminology.

In an article signed C. R. Niven which appeared in the *Lancet* of September 12th, 1903, we are given a definition of the words "variation" and "acquired trait" from, as I understand, the Reid school point of view. The writer tells us that "a variation or inborn trait may be defined as one which arises in an organism in consequence of changes previously produced in the germ cell or cells from which the organism sprang; whereas, an acquired trait may be defined as one arising in the body cells from the action of the environment. It is thus evident that the difference between the two is essentially one of origin."

These definitions contain a fallacy, in that there is no definite contrast between them, as the writer assumes that the potentiality of reproducing an acquired trait cannot be imparted to the germ cells, in order to prove that characters are not trasmitted; but it cannot be presumed that germ cells forming a fertilised ovum do not carry with them the potentiality of what they subsequently develop into; and an acquired trait, to be transmitted, must do so through the germ cell or cells, which must be accordingly modified to carry the potentiality which is to develop, in the organism of the resulting ovum, the trait acquired in the parent (which, of course, Weismannists most vehemently deny). Yet it follows that an acquired trait transmitted can be traced back to a change in the germ cell or cells of the ovum which formed that organism, just like a variation as defined by Mr. C. R. Niven; the only difference, apparently, is that the previous phase, in the origin of a transmitted acquired trait, can be traced to a change in the soma cells of a parent organism; whilst the variation can be traced no farther than the germ cells, at least taking the definition of Mr. C. R. Niven, although few scientists will be satisfied that it originates there without a cause traceable further back. We are invited, however, to infer that the cause is not to be looked for in the soma cells of the parent, but both would be traceable to the germ cells, thus establishing no specific difference in their origin. Further, Mr. Niven, under stress of theory, is very anxious to do away with the term "acquired trait" the moment such "acquired trait" has once been transmitted. He tells us that its transmission destroys its acquired character, and he calls it then a variation; yet the practical point to remember is this: If he formulates a principle that acquired characters are not transmissible, it follows that all efforts on the part of individuals are vain in the progress of the race, and this Weismannists themselves contend, and can only maintain by contending that acquired characters become variations or something else the moment they have been transmitted, if they are transmitted at all; but it matters not what name we give them, if the characters which compose our individualities have once been acquired and transmitted or inherited and accumulated from the inception of our race down to our day, it follows, in the general acceptance of the term, that acquired characters are transmitted, and that individual efforts contribute to the progress of the race. The shuffling of the meaning of the words "variation" and "acquired trait" cannot alter that fact, as it is the realities we must keep in mind and not the words to which any meaning may be conveniently attributed to suit and bolster up a theory.

Neither does the definition of an acquired character given in the *Encyclopædia Britannica* in Art. "Heredity," New Vols., appear to me perfectly satisfactory. It runs as follows: "If an abnormal epigenetic factor be applied during development, whether to the embryo *in utero*, to the developing child, or in after life, abnormality of some kind will appear in the bone, and such abnormality is a good type of what is spoken of as an 'acquired character.'"

When an abnormal epigenetic factor is applied to an organism there may be three distinct processes set up in it. The reaction induced may be:—(1) Reparation and immunisation, as in the case of diseases such as small-pox, syphilis, fevers, tumours, cancer, alcoholism, etc., when the resulting acquirement would be of an immunising nature. (2) Development and integration, as in the case of development or improvement of organs, muscles, etc., by exercise with acquirement and accumulation by heredity. (3) Atrophy and disintegration, as in the case of disappearing organs, muscles, bones, etc., such as we observe in rudimentary organs gradually vanishing under the influence of disuse, and slow loss by disintegrating heredity. Acquired characters, therefore, may be in the form of immunisation, integration, or disintegration. If these distinctions were kept in view there would be less confusion in discussions on such subjects, in which each disputant often assumes what best supports his preconceived notions, and greets his opponent with uncomplimentary epithets for not accepting his unexpressed views; for instance, in discussions on the inheritance of intemperate habits, one side will assume that the taste or desire for alcohol increases by heredity, the other that immunity from that desire increases by heredity, two views which destroy each other. But acquired characters of the second distinction are more generally of the nature of an addition to some already existing organ, such as the further development of some muscles or sets of muscles, or of a musical voice from the voice of our savage or simian ancestors, or of the mentality of civilised man from that of the untutored savage, etc., and could hardly be properly designated as abnormalities. The inception of the formation of a new organ, although, from my point of view, not outside the realm of "acquired characters," as I will endeavour to show further on, must partake more or less of a fortuitous occurrence, coupled with the potentialities of the organism and the stimulus of the environment, but this is rather a remote point to take into consideration. The most practical and interesting aspect of the question is the further development or modification of some already existing organ, such as the musculature, the brain, the organs of sense, etc. In fact, the question constantly presents itself whether the continued and proper exercise of these organs helps in the progress of the race, and the definition of an "acquired character" which I would prefer is the following:—An "acquired character" is a development or a modification of a development in the somatic cells of an organism, produced by the reaction of that organism upon the stimulus of the environment.

MISTAKEN RESULTS.

Just as Weismannists look to the wrong ontogentic time to find the hereditary results of long residence of Europeans in India, of the long established custom of circumcision among the Jews, and of compression of the feet in Chinese women, so they look to the wrong place to find any physical or mental acquirement. They look for large biceps muscles in the arms of children of blacksmiths, for large gastrocnemii in the legs of children of dancers or of runners, for the production of madrigals by the children of great poets, etc.; which is like looking for the projection of a drop of water thrown into the sea at the spot where it fell, because every additional acquirement in evolution is blended into the general population, and the following quotation will illustrate this statement:—"It has been computed (*Enc. Brit.*, Art. 'Heredity,' New vols.) that, in the tenth generation, a man has 1,024 tenth grandparents and is thus the product of an enormous population the mean of which can hardly differ from that of the general population. Hence this heavy weight of mediocrity produces regression or progression of type," and tends to distribute over the general population any acquired character in a way comparable to the distribution of water thrown into the sea. "Thus, in the case of height, a large number of cases being examined, it was found that fathers of a stature of 72 inches had sons with a mean stature of 70·8 inches, a regression towards the normal stature of the race. Fathers with a stature of 66 inches had sons with a mean of 68·3 inches, a progression towards the normal," with, however, a perceptible influence of individuality upon the mean of each class compared with the mean of the general population; but it must be observed that the majority of the sons of fathers of a stature of 72 inches must have been of a smaller stature than their fathers, leading an observer to infer, if this fact alone be taken by itself, that the characteristics of the stature of the fathers were not transmitted. A similar observation can be made with regard to the sons of fathers of a stature of 66 inches, showing that the results of transmitted characters, acquired or otherwise, must be looked for, not in the immediate individual offspring, but in the progress of the general population. An acquired character limited to one or a few individuals only, is not in evidence in the offspring, because it is overwhelmed by the force of heredity, and although it adds its quota, the proportion of its effects is too small to be perceptible. It is only when a whole race of individuals contribute in common for a long time to the development of a character that it becomes evident.

THE MAIN ARGUMENT OF WEISMANNISTS.

The *pièce de résistance* in arguments, however, with Weismannists against the transmissibility of acquired characters is that the supposed independence of the germ cells and their assumed different nature from the soma cells preclude the possibility of the latter influencing the former in such a way as to endow them with the power to reproduce in the offspring organism, under the circumstances of a suitable environment, characters acquired by the soma cells of the parent organism.

I contend that our present knowledge does not warrant us in denying such possibility. On the contrary, we have so many examples of different potentialities in embryos, and therefore, in germ cells of different species of animals which, in appearance, cannot be distinguished one from another except in their final results, and we know so little of the intimate manner in which these potentialities are generated, that we are not justified in pronouncing upon the possibility or impossibility of any given results in such cases, less so in denying them, considering the proximity and relation of the germ and soma cells, their common environment, and their common nature, at some period or other of their life.

Much has been said about the difference observed between different offspring of the same parents, even between different pups of the same litter, to show that acquired characters are not transmitted, but no attempt has ever been made to show that any of those different characters were not to be found in the ancestry of such offspring. As it is well known that no one descendant can inherit all the characters of his long ancestry in the same degree, this can account for all the differences found in the various offspring of the same parent.

But we have the fact that children inherit the main characteristics of their parents, and how can we best account for these resemblances? If it be assumed that the germ cells coming from the same source will produce the same results by repetition of the same process, as castings from a common mould, then we seem to have no guiding cause to assign for the increasing potentialities stored up in the germ cells during the progress of the evolution of life and the special adaptation to the environment. Besides, germ cells are not as castings from a common mould, as they gradually evolve from the primordial cell to an infinite variety of species of great diversity, each of which must be considered as a different mould though arising from a common origin, to say nothing of individuals. As each individual begins its existence from one cell, this one cell, in the highest animals, must have acquired its diversified complexity by a progressive addition and storing up of potentialities from the beginning of life history on earth, and these potentialities must have had their source in the environment as a touchstone to guide the self-adapting reaction of the cell or organism, and must have been transmitted from generation to generation, and the most important part of the environment of the germ cells, in the case of the higher animals, at any rate, is the somatic cells, which act as a host to them and foster and nourish them. Then how are these potentialities generated? Is it the result of chemical combination producing new compounds having new properties by the addition of some element or the modification of the combination of those already existing; or is it the result of a physical process, such as the induction of a new motion, or a modification of the existing motion in the cell; or, again, is it by a process that should be designated as vital? These questions are too speculative to be answered with confidence.

Evolution of the Organs of Sense.

But we have facts in the history of the evolution of life which can throw considerable light upon the *modus operandi* of nature in building up living organisms, which, to me, represent typical examples of transmission of acquired characters and which I will now try to elucidate.

To this effect I will advance the theory, which I shall endeavour to demonstrate, that the senses themselves are the result of a development due to the environment acting upon a responsive organism endowed with common sensation by the accumulation of acquirements and transmission from generation to generation, and even from species to species. For instance, the eye is the outcome of the continual play of ethereal waves upon a responsive and self-adapting organism. First, in the lower forms of life, we find common sensation undifferentiated, but, as we ascend the scale of evolution, we find a differentiation from this common sensation towards the formation of an organ of sight by an initial grouping together of a few pigment cells, then a folding in of the integument, followed by the formation of a lens, and, finally, after a long series of evolutionary stages, extending from primeval life to our day, we arrive at the elaborate visual apparatus which we observe in man.

In a similar manner the organ of hearing is developed under the influence of continual aerial vibration acting upon a responsive and self-adapting organism differentiating itself from common sensation by virtue of its own reaction. Similarly, also, the organs of taste and smell, etc., are developed under the influence of their respective stimuli derived from the environment, and these acquired developments are transmitted by heredity to the offspring as soon as they are evolved by the reaction of the organism.

EVOLUTION OF THE AFFERENT OR REACTIVE SYSTEM.

Along with the development of the senses, which it may be convenient to call the afferent system, for receiving the stimuli from the environment, nervous centres also arise to receive impulses from the senses, producing in those centres certain states of consciousness, and to issue excitations to another set of organs, which is developed *pari passu* with the afferent system, to carry out certain reactions for the welfare, preservation, and adaptation of the organism. This latter set of organs comprise the muscles, skeleton, etc., and may be called its efferent system. When a voluntary act has been frequently repeated for a long time, it becomes involuntarily performed as a result of the repeated stimulus which originated it, until it may become a pure reflex. We have examples of this in a child learning to walk, when every step is studied, thought out, and accomplished as the result of an effort; but in course of time walking becomes almost mechanical. Or in one learning to play the piano, when every note is thought out consecutively, and even the movements composing the execution of each note are studied; but after sufficient practice a piano player may execute the most difficult pieces, even when engaged in conversation, without the slightest effort.

First impressions are collected by the peripheral nerves and senses and stored up in nervous centres, where they become states of consciousness which are renewed and strengthened by every repetition of those stimuli, and, with these, the excitations and various adaptive reactions which they evoke.

As these successive actions and reactions are being continually repeated in regular order, they cohere into definite groups, which, in course of time and generations, become more and more inseparable, thus constituting natural inclinations, habits, customs, instincts, or even emotions.

As an example of a very high development of instinct, we may instance flycatchers. These birds have been known to catch an insect with their beak immediately after coming out of the egg shell. How do we explain that? We have the fact that flycatchers feed entirely on flies and other winged insects, which they catch as they fly, and this skill in catching flies is the evidence of a storehouse of impressions and excitations or actions and self-adapting reactions acquired through the long-continued use of those organs by a long ancestry.

In my own opinion, it is only an organ in greater or less perfection, or an increased development of one, which can be transmitted, and not an action, experience, or memory, or instinct, that is, that our actions or experience must materialise into an organic development to become transmissible. But, as an organ is specially adapted to perform a certain function only, as, for instance, a muscle can only contract or relax in response to any kind of stimulus, or the eye can only perceive light as a reaction to any stimulus, even to a blow, if it respond at all, it follows that the first functional acts of an organ, after birth, irrespective of practice or experience, are determined by its structure reacting upon a stimulus to which it can respond, and any further development of it is directed by its function; hence, an organ or a group of muscles will more readily respond to a stimulus at the time of birth, before any experience or practice has been acquired, the more perfectly such organ or group of muscles shall have been developed by acquirement and heredity, and, conversely, the more or less perfect performance of any function at birth implies the more or less perfect development of the organ involved in the performance of that function.

So long as the same environment persists, the same stimuli are in action, and impulses, states of consciousness, and excitations tend to improve the condition of the efferent system in the exercise of its reactions as required by that environment, so that an organism, at any moment of of its development, is the outcome of the various natural forces and stimuli which have acted upon its ancestors to develop its afferent system and of the various excitations and reactions which have gone to form its efferent system.

But when a species is thrown into a new environment, the stimuli received from that environment are responded to by the existing efferent system of the organism, and adaptation is effected in proportion to the adequacy of the organism and the time the new environment is maintained. If its reaction be ineffective in carrying out the necessary adaptation, the species gradually dies out and becomes extinct, but if it succeed in adapting itself to its new environment, the organism develops on other lines. Some of its organs, hitherto indispensable to the maintenance of the species, become unimportant and atrophy from disuse, and are transmitted to the offspring in that atrophied and undevelopable condition. Examples of these can be found throughout nature, but in man we have the atrophied muscles of the pinna of the ear, the panniculus muscle, the nictitating membrane, the caudal vertebræ and muscles, the vermiform appendix, etc., etc., which go under the name of rudimentary organs, but are the remnants of once active organs which have become atrophied through disuse and transmitted in that atrophied condition.

It will be seen from the foregoing explanation that the longer an organism is submitted to a particular environment, the more perfect and effective becomes its efferent system for the exercise of its functions in that environment, every habit, instinct, emotion, etc., contributing to further development by continually repeating reflexly the same groups of actions and reactions, the process working in a cycle of acts which are in turn both cause and effect, the environment acting as a cause to stimulate the afferent system, the afferent exciting the efferent, and the efferent acting upon the environment.

THREE ARGUMENTS.

(1) The natural forces are the cause of the development of the organs of sense in a suitably reacting organism.

But what is the evidence, one may ask, that light or ethereal vibration is the cause of the evolution of the eye; aerial vibration, that of the organ of hearing; chemical action, that of taste; chemical emanation, that of smell, etc., etc., and that it is an acquirement and not a power residing solely in the germ plasm?

The evidence is that eyes will not be generated in the absence of light, nor organs of hearing, of taste, of smell, etc., in the absence of their respective natural stimuli. Moreover, we find that in animals in which the organ of sight has been developed, it will atrophy and become useless, as we find it to be the case in certain fishes living in dark caverns, irrespective of the potentialities of the germ plasm, if the action of light upon it is withdrawn for a sufficient time. It follows that light is the cause, not only of the development of the organ of sight, but that it is also indispensable for its maintenance when once developed. We may add that the special responsiveness of the organism is no less necessary, because light will not produce a visual organ upon a stone or any other object not suitably responsive; but it may be observed that the initial action towards the formation of an organ of sight would be from ethereal vibration and not from the organism, for the organism cannot respond in that direction in the absence of that special stimulus.

The same reason is applicable to the development of other organs of sense, and the absence of their respective stimuli will have the effect on them that we can observe in the rudimentary organs which are to be found in all the higher animals.

(2) *Potentiality of the germ cells derived from the soma cells.*

Can we presume that the germ cells acquire the potentiality of developing such perfected organs as we find in the higher animals, for instance, without deriving any influence from the trained soma cells? I cannot think so, since when the environment is removed and the soma cells cease to act on the environment in consequence, the germ cells gradually cease to reproduce such development in the succeeding offspring concomittantly with the removal of the environment, and during the period of disintegration of these organs they are retranslated in the offspring in a gradually decreasing degree of perfection *pari passu* with the disintegration of the organs in the soma cells of the parents. It must be then that this acquired character in the soma cells is retranslated and reappears in the offspring through a potentiality developed in the germ cells after the environment has been modified and the soma cells of the organ affected by the change, for we find that a fly-catcher, for example, coming out of the egg shell, can at once catch an insect with its beak, through, of course, a suitable efferent development; whereas, if the species be removed from its fertile environment, the germ cells will gradually cease to produce the efferent system capable of performing this function, which will gradually atrophy until it can no longer be developed in perfection in any of the individuals of the species during a lifetime, without a long series of generations placed again in a suitable environment to redevelop the atrophied organs. Why, then, should the germ cells cease to reproduce, in the offspring, a perfect organ, at the time that same organ is being atrophied in the parent by the modified action of the environment if the soma cells of the atrophying organ have no influence upon the germ cells? or is the germ plasm a little wizard that it can predict so accurately the change in the environment and modify its tactics accordingly?

(3) Weeding out inadequate to account for the transmission of rudimentary organs and for continued improvement.

The Darwinian theory of the "survival of the fittest" is, indeed, a grand conception, and most true to account for much progress and many changes occurring in the history of evolution, but it will not account for every change in evolution.

(a) It will not account, alone, for the results we observe in the production of the so-called rudimentary organs, for it cannot be held that fishes living in dark caverns, for example, having lost their sight through some mysterious property of the germ plasm, they seek dark caverns, because there seems to be no reason why a blind fish should seek a dark cavern in preference to a light environment; nor can it be contended that, having come to dark caverns by accident, those fishes which have eyes that they do not require die off, and the blind ones survive, for there seems to be no reason why a fish possessing a perfect organ of sight should be at any disadvantage, even living in a dark cavern, in the struggle for existence with another fish of the same species possessing an imperfect and atrophied organ, which it can make no use of, and we can find no reason why the former should die off and the latter survive in consequence; no more would a man able to prick his ears like a dog, or having an acute scent like a savage or a bloodhound, be in any danger of being weeded out for that reason, as this puts him at no disadvantage among other men in the struggle for existence, and the germ plasm should, therefore, continue to reproduce these organs in perfection in the face of disuse if the atrophy of those organs in individuals had no influence on the germ cells in the reproduction of the same defect in the offspring. There seems, therefore, to be no doubt that the atrophy of these organs is due to disuse, and not to weeding out, and is, therefore, acquired, and, moreover, transmitted, since, after a certain number of generations, these atrophied organs cannot be redeveloped in the lifetime of one individual, even in the most suitable environment; and, if it is demonstrated that disuse produces atrophy, disintegration, and, finally, disappearance of organs by gradual disaggregation and transmission from generation to

generation, does it not follow that the converse is true, namely, that adequate exercise, growth, integration, and, finally, perfection of organs is the result of gradual acquirement and transmission from generation to generation?

(*b*) However, the "survival of the fittest" does not appear to adequately account for the continual improvement going on in progressing organisms; for a species could not, by natural selection alone, without increased development by exercise, reasonably be expected ever to produce offspring of a higher type than the mean between the two highest individuals, male and female, of the species, at any one time, and there appears to be no other reasonable cause assignable for any further improvement beyond that point than the additional power imparted to the organs by exercise with further development and transmission of that acquired development by imparting to the germ cells the potentiality of developing it, though this be the bugbear of Weismannism.

RECAPITULATION AND CONCLUSIONS.

We may now recapitulate the facts upon which the theory of the transmissibility of acquired characters rests. We have the fact of acquirement of immunity in individuals, as in small-pox, syphilis, exanthematous fevers, etc., coupled with the fact that in the course of generations a race exposed to such diseases becomes more and more immune from them. We have the fact of acquirement of characters in individuals from training and education, such as muscular development from exercise, development of the lungs by breathing exercise, of the voice by singing, etc., and mental development from teaching; this coupled with greater physical development in races given to physical exercise, and higher mental efficiency in races which have been longest under the influence of education. We have also the fact of atrophy in indviduals of muscles and organs from disuse, coupled with atrophy of muscles and organs in races in which such muscles have become useless from a change of environment, giving rise to what are called rudimentary organs.

It has been denied that acquired characters are transmitted because, among other reasons, children of European descent born in India, even after several generations, are born just as white as children born in England; because Jews, after the practice of circumcision during a long chain of generations, have children born with a prepuce of the same size as Gentile children, because no change has been observed in the Chinese baby's foot as a result of the practice of compressing the feet in Chinese ladies from time immemorial, also because European civilised girls show as much aptitude for mental development as boys, and because the children of blacksmiths have no larger biceps muscles than other children, etc. We have shown these arguments to be fallacious, and have pointed out by illustration of statistics of inherited stature that transmitted characters blend into the general population, and should not be looked for in individual offspring but in the general progress of a race. We have also pointed out special developments, such as is seen in the fly-catcher evolving under the prolonged influence of a suitable environment, the same environment producing a similar development in individuals which is admittedly acquired, and is to all appearance the same process observed ontogenetically, as can be seen in the phylogenetic evolution of the special character of the fly-catcher by the persistence of the particular environment. Can it be supposed that the fly-catcher would go on developing in the direction of greater skill in catching flies if the whole species were removed to an environment where there were no insects to catch? Would it go on catching by virtue of its germ plasm even in the absence of something to catch? And, if not, would not the group of muscles involved in that act gradually lose its effectiveness and go the way of other rudimentary organs and be transmitted as such. Then, surely, the environment is the developer and maintainer of that character, which is consequently acquired.

We have shown the evolution of the organ of sight as a typical development by the transmission of gradually acquired characters, which is, therefore, an example of a necessary influence of an acquired trait in the soma cells upon the germ cells of future generations, to retranslate in the offspring organism the character which has been acquired in the soma cells of the parent organism. We have shown that the atrophy from disuse, resulting in what are called the rudimentary organs, and which is, therefore, acquired, is likewise transmitted, as the resulting condition cannot be due to weeding out of the more perfect individuals and the survival of the less perfect, showing that weeding out or natural selection, although a most potent factor in evolution, is not sufficient to account for all the results obtained and that the transmission of acquired characters is the only adequate complement to natural selection as an effective cause of the results of evolution, and is the true explanation of many processes not otherwise accounted for.

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